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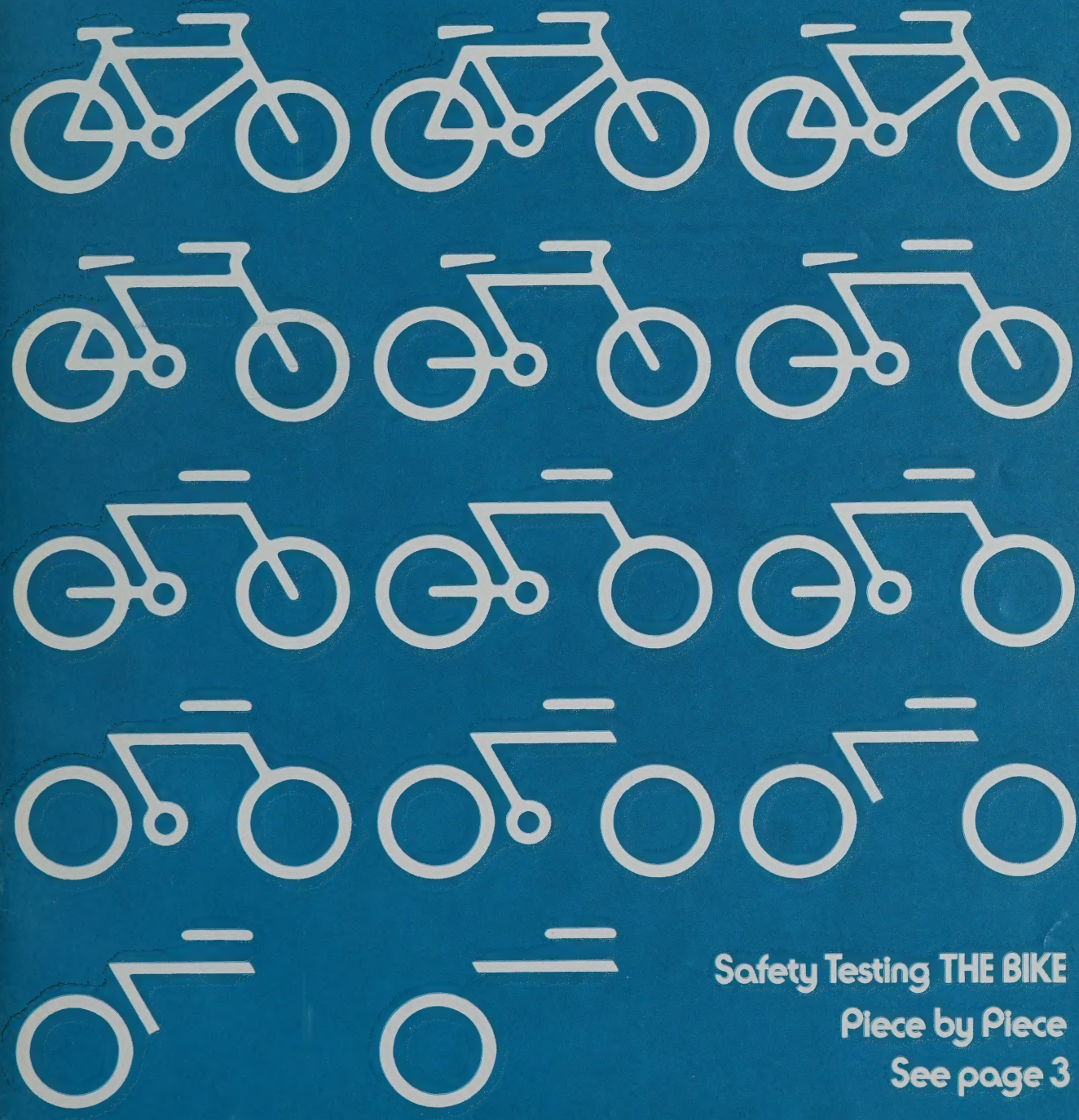

Safety Testing THE BIKE Piece by Piece

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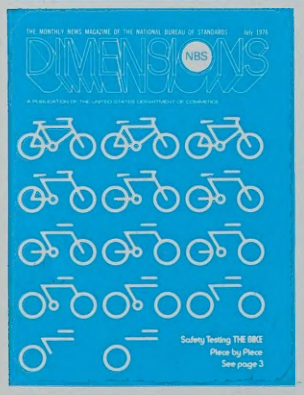

Cover: NBS has contributed to making bicycling a safer sport. See story beginning on page 3.

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:
The Institute for Basic Standards
The Institute for Materials Rsearch
The Institute for Applied Technology
The Institute for Computer Sciences and Technology
Center for Radiation Research
Center for Building Technology
Center for Consumer Product Technology
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by Michael Baum
staff writer

Safety on Wheels

NBS Contributes to New Bike Regulations

MILLIONS of Americans—close to 100 million, according to one industry estimate—are taking to the roads on bicycles. Cyclists are pedaling around the country, armed with clip-on water jars, knapsacks with the legend "Don't tread on me," and a host of other accessories that go with one of the fastest growing participant sports in the nation.

As a pastime, however, bicycling is not without dangers. Carelessness on the part of the cyclist, or of others around him, sheer mischance, or defects in the design and construction of the bike itself contribute to thousands of injuries in bicycle-related accidents each year. The Consumer Product Safety Commission (CPSC) estimates that there were over 476,000 such injuries in 1975, and bicycles are at the top of the CPSC Hazard Index of consumer products involved in accidents.

Regulations

On May 11 the CPSC's new mandatory bicycle regulations for manufacturers and dealers (16 CFR Ch. II, Part 1512) went into effect. The regulations, for the first time, set mandatory minimum requirements for the construction and performance of new bicycles sold in the United States, with a few exceptions.* To enforce the new regulations, the CPSC will rely, in part, on a series of 26 tests that push, pull, prod, and otherwise stress all important parts of the bike. Most of the procedures by which CPSC will test for compliance with the regulation were developed by the National Bureau of Standards.

NBS has been interested in developing test procedures for bicycles for 5 years, according to Walter Leight, chief of the NBS Office of Consumer Product Safety. NBS originally began work on the problem under contract to a predecessor to CPSC, the Bureau of Product Safety of the Food and Drug Administration. After the creation of the Consumer Product Safety Commission in 1973, the bicycle test project became a joint effort between NBS and the CPSC's Bureau of Engineering Sciences.

According to Leight, "The Commissioners have the regulatory power to specify what is required for compliance and to enforce compliance. We provide technical support in designing the tests."

NBS Role

The NBS tests were developed by Donald Marlowe, an engineer in the Mechanics Division of the Institute for Basic Standards, and by William Venable, a physicist in the IBS Optical Physics Division. The tests range from the simple (pulling the drive chain until it snaps) to the complex (measuring the coefficient of luminous intensity of the safety reflectors).

Developing standards for bicycle performance, according to Leight, first meant determining what factors of design and performance were important to the safety of the rider. Little information was available due

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* Not covered by the CPSC regulations are "track bicycles," designed and sold as competition bikes, with "tubular tires, single crank-to-wheel ratio, and no freewheeling feature between the rear wheel and the crank," and "one-of-a-kind" bicycles that have been custom built out of non-stock parts to the customer's specifications. In addition, certain paragraphs of the regulations, such as one governing protective chain guards, do not become effective until November 13.

to the earlier lack of formal standards for bicycle construction—there were no mandatory rules and only a limited set of voluntary standards used by the industry. The first step was a study of bicycle related accidents to identify the causes of injuries. Many accidents, of course, are caused by factors unrelated to the design of the bike, but the CPSC has estimated that 17 percent of bicycle related accidents are caused by faults in the bicycle. The new regulations, it feels, will substantially reduce that 17 percent.

Most Common Failure

"The most common failure we found," recalls Marlowe, "was seat clamp failure. We tested 15 bicycles and 12 didn't have seat clamps strong enough to pass the regulation."

Seat clamps must now hold tightly enough, when properly assembled, to resist a force of over 667 newtons (150 pounds force), pressing down on first the front and then the back of the seat, without moving. They must also resist a force of 222 N (about 50 pounds force) from the side at the front and back of the seat without moving.

During a 2-day seminar sponsored by CPSC and NBS last April, representatives from 55 manufacturers had a chance to see the seat clamp test and the other new test methods demonstrated and to talk to the men who designed them. The Commission emphasizes that the NBS/CPSC test methods are not the only ones that are suitable for checking whether or not a bicycle complies with the regulations, and that other equally valid methods may be used by manufacturers to check their products. But all bicycles will have to be capable of passing a CPSC test.

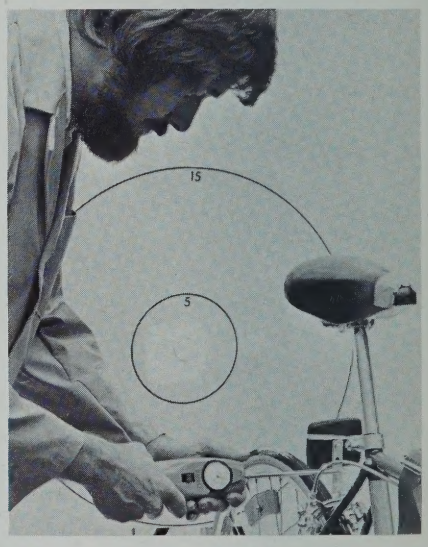
Types of Tests

Examples of tests on the structure of the bike include: *The drive chain test*—The chain is placed in a testing machine and pulled: It must withstand, without failure, a force of no less than 8010 N (1800 pounds force), or 6230 N (1400 pounds force) for sidewalk bicycles. Requirements are generally less stringent for "sidewalk bicycles," the small bikes used by young children.

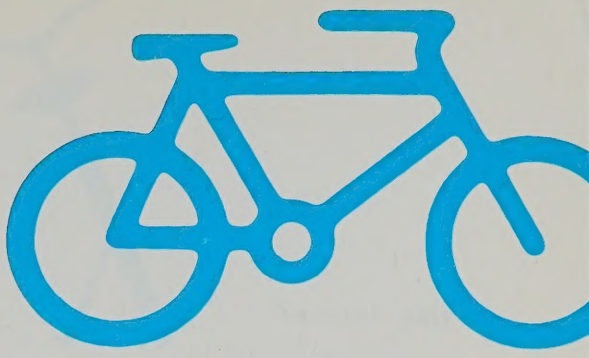
The handbrake loading test—Handbrakes are tested with force gages that allow the test engineer to squeeze the brake lever with a measured force of 445 N (100 pounds

photos by Hank Glittenberg

Children's "sidewalk bicycles" (those with seats that will expand no higher than 635 cm above the ground) are tested somewhat differently than bigger bikes. Here CPSC engineer Tom Davis demonstrates the sidewalk-bicycle proof test. The stand holds the bike a measured 30 cm above a paved surface and the saddle bags hold 13.6 kg of weights. The handle bars are also weighted (4.5 kg each), and the bicycle is dropped three times and then inspected for damage.



This CPSC test simulates what happens to the reflector's alignment when someone picks up the bicycle by the reflector mount. A projector in the center of the target behind the bicycle shines a beam of light on a small mirror fastened to the surface of the reflector. The target is aligned so that the reflection of the beam strikes the middle of the target. Using a force gage, the technician pulls on the reflector mount in three different directions with a force of 89 newtons (20 lbf). The movement of the reflection on the target shows how much the reflector's optical axis has been moved by the stress. The image must move no more than 15° during the test (outer circle) and must remain shifted no more than 5° after the test (inner circle).



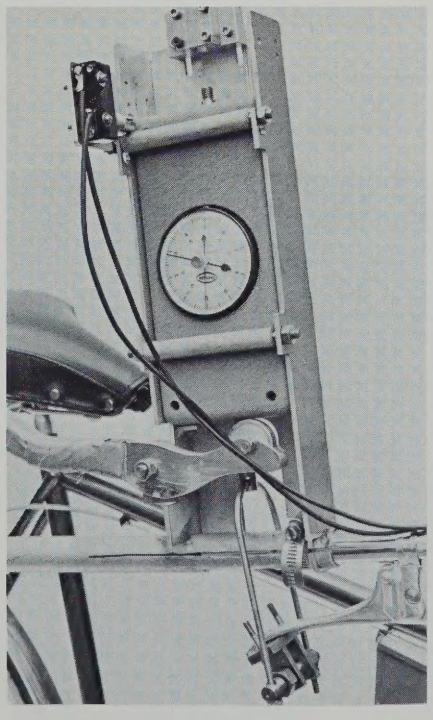
force), or until the brake lever presses against the handlebar. This is done 10 times for each brake lever and each extension lever, and the whole brake system is inspected for fractures or other failures. The distance between the brake lever and the handlebar is measured before and after the test to make sure that the lever has not been bent out of shape.

The reflector mount and alignment test—Some tests determine whether or not the bike will stand up to a reasonable amount of abuse. In this test of the reflectors fastened to the front and back of the bicycle, for example, a small plane mirror is fastened to the front of the reflector facing in the same direction as the "optical axis," or principal direction, of the reflector. A narrow beam of light is bounced off the mirror to a target disk to determine how the optical axis of the reflector moves during the test. A technician with a force gage pulls on the reflector with a force of 89 N (20 pounds force) to simulate a person picking the bicycle up by the reflector. If the reflector is bent more than 15° out of line while the technician is pulling on it, or remains bent more than 5° out of line after the test, it fails.

Design and Performance

Other tests check the design of the bike, assuring, for example, that no bolts, clamps, or other hazardous protrusions stick out where they may catch the rider. The bike is inspected to make sure that there are reflectors on the front, back, and sides, that there is a guard plate over the drive chain, that the ends of the control cables are capped or otherwise treated to keep them from unraveling, and that the pedals have clips or tread surfaces to keep the rider's feet from slipping, to give a few examples.

The regulations also provide for performance tests, such as one in which the bicycle is ridden several times at a speed of at least 24 km/h over a 30 meter course lined with wooden cleats 25 mm high, and then inspected for damage.



This force gage loading mechanism is part of the setup used to test bicycle handbrakes. The apparatus allows the technician to apply a measured force of 445 newtons (100 lbf) by squeezing the top lever. In the actual test this is done 10 times for each brake, after which the entire brake system is inspected for defects or failures.

New Instrument

A bonus for NBS that came out of the bicycle test program was the development of the Long-range Reference Retroreflectance Instrument (L.R.R.I.) by the Radiometric Physics Section. Venable, who supervised the project, believes that the L.R.R.I. will allow NBS to develop a series of standard reflectors within a year.

Retroreflectors, as distinguished from ordinary reflectors such as plane mirrors, are designed so that light striking the reflector from any angle reflects back towards the source of the light. Most reflectors used on bicycles are retroreflectors, and CPSC regulations for retroreflector performance require measuring the coefficient of luminous intensity (C.I.L.) of the retroreflector. The C.I.L. is the ratio of the apparent candlepower of the retroreflector in the direction of the observer to the illumination received from the source. CPSC regulations specify minimum C.I.L. values for different angles of incidence and different colors of reflectors.

Similar Tests

The actual retroreflector tests developed for the CPSC are not particularly novel, according to Venable.

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Tests for prismatic reflectors (the small plastic retroreflectors that look like collections of tiny reflecting cubes sealed in a plastic bubble) are modified from similar tests used for reflectors on cars and trucks. Tests for tires with retroreflective sidewalls, which are becoming popular, were adapted from procedures used to test sheet reflectors for highway signs.

"The principal thing that grew out of this project which I think will be a help is the establishment of a highly accurate measurement capability that we didn't have here before," said Venable.

New System

The bicycle test project, according to Venable, led to the building of the Long-range Reference Retroreflectance Instrument, a specially designed system of projector, receiver, filters, automated test mounts, and computer controls in a light-proof tunnel that allows for highly accurate measurements of the coefficient of luminous intensity for different retroreflectors under different conditions.

"The current state-of-the-art in retroreflectors is a typical measurement error of from 5 to 20 percent," according to Venable. "We're shooting for a capability of 1 percent error for our standard retroreflectors, which, when carried over to industry to use in their own tests, will allow them measurements accurate to within 3 to 5 percent uncertainty."

Reflectors

Another use of the L.R.R.I., he says, may be to develop performance guidelines for reflectors used in various special applications, such as overhead signs on highways, or the reflectors on airport runways.

A cyclist himself, Venable takes a personal interest in the CPSC testing. "The best thing you could say for bicycle reflectors before the regulations were announced was that they were miserable, most of them," he comments. "They cracked, fell off the bike, leaked water, which makes them useless, and so forth. Now the typical reflector has a strong backing, it's hermetically sealed and doesn't leak water, and in general the amount of light you get back from a typical new reflector is 10 times more than from the old reflectors." The standards are now actually higher than those for reflectors for cars, he says.

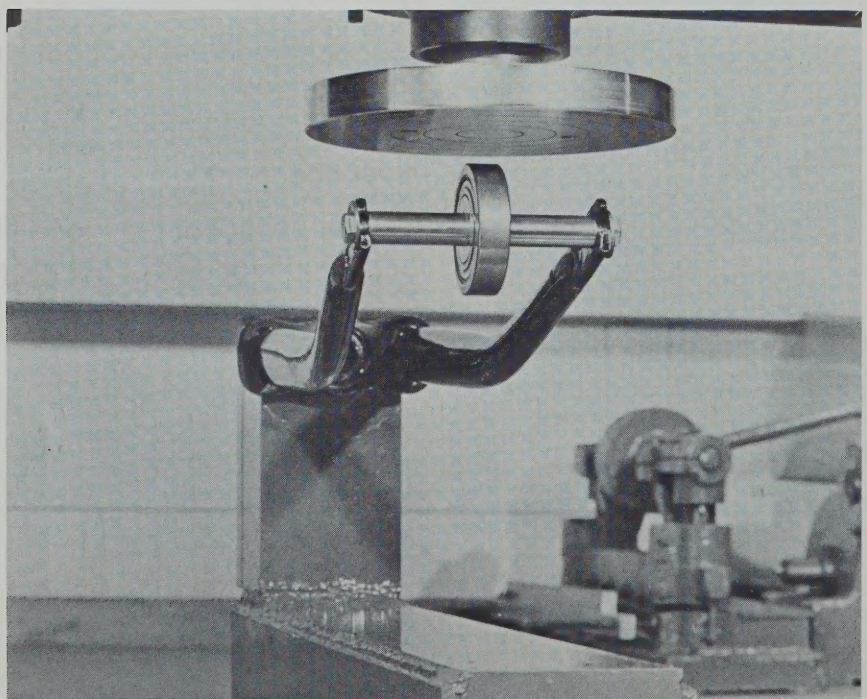
Subjective Factors

Although the CPSC regulations are now in effect (with the exception of the few requirements that become effective in November), NBS engineers are still interested in tests that would eliminate the relatively subjective factors in some of the present test methods. One example is the road braking test, "where," according to Leight, "you must consider such factors as the weight of the rider, the wind, the friction of the road surface, and so forth. We'd like to do away with that and do the tests without the human elements and track conditions, since they require the use of correction factors when analyzing the data."

And Venable, speaking to visitors at the Bicycle Testing Seminar, summed the project up, "As a driver who has an aversion to running over people and as an enthusiastic cyclist myself, I hope all the bicycles pass.

"As scientists, we'll find out how well they do work. That's what we're here for." □

According to the new CPSC regulations for bicycles, the front fork of the bike must be capable of absorbing a certain amount of energy without being damaged or deformed. While a v-block holds one end of this fork rigidly in place, a test machine presses down on the other end until it is bent a distance of 64 mm. To pass the test, the fork must absorb 39.5 joules of energy (350 in-lbf) without bending more than 64 mm.



Computer Auditing Increasingly a Necessity

*by Ruth M. Davis**

COMPUTER auditing is a key to one of the most crucial issues facing us today. Computer errors, failures, and foul-ups have become highly visible. The problems resulting from them can be catastrophic, extremely costly, and injurious to individual rights.

Efforts required to remedy the problems of computer systems performance are extensive and multifaceted. Because no one approach is broad or comprehensive enough, the NBS Institute for Computer Sciences and Technology (ICST) has coined a new term—functional fidelity—to describe the collection of functions needed. Functional fidelity is defined as the accurate performance by a computer system of all of its required functions and the surety that the system does not perform any unintended function.

Computer Systems

Actions taken by computer systems are generally of two types. They may control the action in real time of manipulators, on-going processes, or moving objects. Examples are industrial robots, automated process control, and rapid mass transit systems.

They may also produce informational products which feed into administrative or management processes triggering a number of actions in a given organizational framework. Examples here include funds disbursing, inventory replacement, and actions taken about an individual such as credit justification. Another class of systems of concern consists of computer-based mathematical models. Such models are generally used for planning and policy formulation. They include models for air pollution, water resources, urban development, solid waste management, energy production, education, transportation, health services, law enforcement, and criminal justice.

Functional Failures

Generally, the history of computer system design shows little attention has been paid to the development of design practices to avoid functional failures. The aims of such design practices are illustrated by the possible effects of failures. In real time control systems such as air traffic, rapid mass transit, nuclear power, and intensive-care patient monitoring, failures are generally catastrophic and can result in loss of life and property.

Failures in systems whose information products trigger sequences of administrative actions, such as criminal justice information, credit verification, voting and voter registration, medical record keeping, and traffic accident reporting, may wrongfully deprive an individual of a right or opportunity that he might otherwise receive. Financial or material transfer systems such as payroll systems, Federal subsidy disbursement systems, depositor-account banking and military material and logistics systems may fail with resulting waste of funds and loss of public confidence. Failure of computer-based models to represent reality may result in decision makers basing policy selection on the wrong information.

Areas of Greatest Concern

Concerns with functional fidelity have been greatest in highly automated weapons delivery systems and

In a real-time computer control system, such as the one used with the new Washington, D.C. Metropolitan rapid transit system, functional fidelity is essential to safeguard both life and property.

WMATA photo by Paul Myatt

* Dr. Davis is director of the NBS Institute for Computer Sciences and Technology.

in manned space exploration systems. Experience indicates that concerns with functional fidelity have been minimal in management and administrative applications such as public benefit systems (for example, social security, insurance, and so on), credit reporting systems, and educational record systems.

Functional fidelity of computer systems can no longer be sloughed off as less important than system speed, throughput time, rapidity of becoming operational, and the other similar objectives of computer systems previously accorded highest priority.

If we look at the question of application software, we find we have few validation and verification techniques available to us. There has been some research on methods of proving program correctness using the concept of inductive assertions, but it does not seem likely that we can apply it to large operational programs in a satisfactory manner anytime in the foreseeable future.

When we consider the question of hardware failure, we add some very real problems. For example, air traffic controllers at the FAA's Air Traffic Routing Control Centers have reported that when the computer fails, their all-important display scopes go completely blank. One result can be that some aircraft come too close together for the manual procedures that must be instituted. This is a problem in functional fidelity failure due to insufficient failsoft and failsafe procedures.

When we add the question of whether the data being employed in the system is correct, we become closer yet to real-world concerns. In fact, well-publicized information about the Social Security Administration's newly federalized Supplemental Security Income program has revealed the fact that hundreds of millions of dollars have been paid out unnecessarily. Here is clearly a question of data control, as well as a question of incorrect algorithms.

Operating Procedures

Testing of operating procedures is one area where substantive work has been done. NASA has successfully run pre-operational checkouts of all systems elements including operations personnel, with the exception that some data is simulated and not real. This type of verification is sometimes referred to as a system simulation, but it is actually the environment which is being simulated. Statistical techniques also may be employed to identify the most failure-prone system elements. Also, failure hypotheses can be instituted which yield contingency plans that compensate for any failure whose possibility can be identified in advance.

The operating records are becom-

Computer systems are used increasingly to initiate actions with little or no human intervention, and assurance of their reliability is of primary importance

ing the focus of attention of EDP-oriented auditors who have begun to delve into the systems that they audit. They now are very concerned about the correctness of all software and about operating procedures which insure physical security, document changes to software, and control the movement of software and data. These efforts are important and welcome, but they do not include the engineering test techniques just mentioned and are seldom applied to non-financial systems. At NBS we are following a proposal by auditors to include in systems an "integrated test facility." This ITF would be a fictitious operation mirroring the real operations going on simultaneously, but it would employ simulated data.

Auditability

The activities associated with functional fidelity of computer systems can be conveniently grouped in terms of measures for auditability, accountability, and performance fidelity.

In 1933, Congress passed the Securities Act and required that all corporations listed on a national stock exchange file an annual financial statement. This statement must be prepared by an independent public accounting firm and the objective of this examination "is the expression of an opinion on the fairness with which [the financial statements] present financial position and results of operations." The function performed by the independent accounting firm is called auditing.

The auditor's examination involves a review of the financial records of the corporation which, before computers, were entirely on paper. They include bills, receipts, bank statements, and inventories of assets.

After the introduction of computers into business operations, a debate ensued in the auditing profession. The question was whether it would be possible to audit "around the computer" or whether it would be necessary to audit "through the computer." Auditing *around* the computer implied ignoring what was in the computer and considering only the computer input and output. It was the auditor's initial response to a new technology with which he was not familiar.

As integrated data bases containing all employee information as well as all inventory and accounting information came into use, it became clear that auditing only around the computer meant essentially auditing only around the corporation, a not very effective procedure.

The introduction of computers into financial recordkeeping systems has created the need for auditing through the computer rather than around it. As a result, definitions of auditing are changing to reflect the importance of information and information handling in systems to be audited.

The definition of "auditing" and "auditability" as a measure of the functional fidelity of computer systems is still in flux and undergoing long-needed revisions.

Accountability

Accountability is a measure and means of validation of functional fidelity of a computer system in the sense that it defines the responsibility of management for the correctness of the products and/or services or its computer system. It does not yet have its own technology.

Accountability is applicable to both real time control systems and to systems whose informational outputs trigger sequences of administrative actions. It is dependent upon and requires agreed-upon statements of system function.

Accountability is that measure which forms the most direct bridge between good information management practices and satisfactory functional fidelity of computer systems.

Performance Fidelity

Performance fidelity may be the oldest practiced measure of functional fidelity of computer systems. It measures the extent to which a system performs correctly its intended functions and does NOT perform any unintended functions.

Performance fidelity is important for all computer systems that initiate actions with little or no human intervention. It is particularly important for real time control systems where later correction of malfunction may be impossible.

The application of the fidelity measure requires statistical and engineering techniques not easy to formalize. Theoretical means of applying the performance fidelity measure do not exist. Measures of the correctness of actions initiated by the real-time computer system must be related to inputs to and signals from the system.

One general method of measuring the performance fidelity of any computer system can be called The Failure Hypothesis Method. Based on well-known mathematical techniques, it requires (a) listing of all possible functional failures (called failure hypotheses) and (b) attempting to prove the failure hypotheses.

Solving the problem of functional

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fidelity is going to require good management practices and new technology. Strong efforts will have to be made to establish standards for performance reliability and to transfer the known technology made available by past successes in defense and space systems. We can see that performance guidelines need to be more precisely defined and methods for their application devised.

Recognizing Need for Auditing

Many managers have recognized the need for internal controls and for the institution of an audit function. Prevention of errors and fraud are but two goals. Determination of the efficient use of resources is an especially high priority.

One strong impetus to audit procedures has been the passage of the Privacy Act, which includes in it a requirement for computer system accountability.

The most recent literature of EDP auditing shows that the procedures that a financial auditor should take are to a great extent independent of the fact that it is a financial system that is undergoing audit. The descriptions of these controls, taken from auditing literature, make it clear that they could just as easily be applied to personal records as to inventories and accounts receivable. Auditing in privacy accounting can build on the experience of financial auditing while keeping its special concerns for the privacy of records instead of the equality of sums.

Although the concepts of auditing non-financial data systems and financial data systems are similar, there are significant differences. Unlike financial data systems, no outside independent professional is required to be called in to audit a personal data system such as a welfare records system, or a criminal justice information system, or a voter registration system. However, with the proliferation of formal data systems of this type coupled with increasing numbers of Federal and state laws mandating privacy protection, it seems reasonable to suggest that for non-financial data systems, auditing by an independent professional in the field would serve a valuable purpose.

NBS Aims

The work of NBS is aimed at formalized techniques of data systems auditing and may help establish the body of knowledge which a professional auditor would use to audit a personal data system. NBS will coordinate this work with professional organizations such as the Institute of Internal Auditors. Such organizations are concerned also about the impact of computer technology on their profession and wish to improve the expertise of their membership to deal with new situations brought about by technological change.

Based on its continuing work in software engineering, computer security, and analysis of computer systems used for vote-tallying, NBS is also working toward the eventual development of guidelines for software auditability.

The concern of the public and the government with functional fidelity is increasing and is directly related to the greater numbers of computer systems responsible for actions impacting on:

- public safety
- public welfare actions
- large funds disbursement
- individual rights
- national security
- daily activities of individuals.

Technological Facts of Life

Concomitant with the demand for more attention directed to this issue are some technological facts of life, namely:

- Little continuous and focused attention has been paid to auditability, accountability, and fidelity of computer systems. This situation needs to be rectified.
- Imposing these measures of functional fidelity into system design and operation will increase the cost of both tasks and will be developed only in response to user demands or to meet standards for functional fidelity. Such demand and standards must be forthcoming.
- The ease of application of measures of functional fidelity is heavily dependent upon computer system architecture and the system software environment. As fourth-generation computer systems are evolved, their architecture should reflect requirements for accountability, auditability, and fidelity.
- The scientific foundation for needed statistical, mathematical and engineering testing techniques, although not foundering, is being enhanced very slowly and quite fragmentarily. More research and development in these areas needs to be promoted by government and the public service sector.

New technology alone, however, will not solve the problem of functional fidelity. Managerial and administrative procedures are also needed. The application of both are especially important as computer systems are used increasingly to initiate actions with little or no human intervention. □

Energy Options for the Future

by Robert C. Seamans, Jr.

Dr. Seamans is the Administrator, Energy Research and Development Administration.

This article is excerpted from a speech delivered on April 2 at the National Bureau of Standards as part of the Distinguished Lecture Series to celebrate the 75th anniversary of NBS.

WHEN we talk of energy self-sufficiency, we tend to think in terms of 5, 10, or perhaps even 15 years. Such vision is necessary because of the long lead times in adapting new energy technologies to the marketplace and the requirements of future generations. Regardless of the lifestyle they elect to follow, our children are going to need energy, and so will their children. The decisions we make today will to a large extent determine how they live tomorrow.

In the past, the growth in the use of energy in our country has been impressive. A hundred years ago, the 58 million Americans then living used a little over 100 million BTU's per person. The 215 million of us now celebrating the Bicentennial Year are consuming nearly 340 million BTU's per capita, a more than three-fold increase.

During the decade preceding the Arab Oil Embargo, the annual rate of increase in U.S. energy demand was about 4.3 per cent. The average American today uses about six times more energy than the average inhabitant of the world as a whole. And, from 71 quadrillion BTU's in 1975, we may be using something like 82 quadrillion BTU's in 1980, 99 quadrillion BTU's in 1985, 115 quadrillion BTU's in 1990, and 156 quadrillion BTU's in 2000.

National Energy Plan

To guide the nation effectively towards a multiple-option energy mix in which such growth can be accommodated, the Energy Research and Development Administration (ERDA) was established on January 19, 1975. Creating a new energy agency was one thing; charting a course the U.S. can follow towards increased energy independence is quite another. The Federal Nonnuclear Energy Research and Development Act of 1974 required that ERDA develop a national energy program and then explain its rationale and the steps recommended to implement it.

Accordingly, in late June of last year, ERDA's report was presented to the President and to the Congress covering a "National Plan for Energy Research, Development and Demonstration: Creating Energy Choices for the Future." One of its fundamental conclusions was that no single energy technology or even select groups of technologies could provide the flexibility and independence the nation requires.

To achieve such flexibility and independence and to allow for some failures in the RD&D process, the report emphasized that "multiple options [must be provided] which, taken all together, could exceed perceived needs." The curtailment of any major existing option, such as the enhanced use of nuclear power or coal, would place such heavy and perhaps impossible demands on all remaining options that a significant reduction of crude oil and gas imports might not be achievable.

In revising the National Energy Plan this past April, account was taken of various technical and scientific advances; trends in energy demand and production; new data on energy resources and reserves; regional, state, and local concern over energy developments and events; commercialization prospects for advanced energy technologies; institutional, regulatory, and legal matters; international developments; and many other factors. Despite changing situations in all

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Profile of a Firebug

by Frederick P. McGehan
NBS public information specialist

HAVE you ever stood at the edge of a roped off area and watched with a mixture of horror and fascination as a building went up in flames and smoke?

Fire has a curious grip on human beings that probably begins with an infant's first view of a lighted candle or match. For some, however, fascination with fire becomes an obsession. It is an obsession that can be costly both to the individual and to society.

Arson Costs

Dr. Bernard Levin, a psychologist on the staff of the Center for Fire Research, the National Bureau of Standards, estimates as many as 100,000 fires each year are set by arsonists. The cost is over $1 billion in property losses. When the many deaths and injuries are considered, the total adds up to about 25 percent of the annual U.S. fire toll.

These figures are only rough "guesstimates" because no one knows how many arson fires there are in any given year. What the experts do know is that there is a great need for more precise data on the arson problem.

Levin recently performed a comprehensive review of professional literature on arson and presented his findings in an article in *Fire Journal*, a publication of the National Fire Protection Association.

Characteristics

A "typical" pyromanic is a young male of below average intelligence

who comes from a broken or disrupted home and has lived under frustrating or harsh circumstances most of his life. There is a strong likelihood his motive for setting fires is revenge against a person, institution, or society in general.

Because the crime can be committed in secret and does not require a confrontation with the victims, "It is often the act of the physically weak and the coward," Levin reports. The arsonist doesn't care about the consequences of his action, although he frequently stays around to view the results and, in fact, may offer to help the firemen. The latter is often a clue for fire investigators.

"It is tremendous power for the powerless at a fire to say 'I know what really happened,' " Levin notes.

The arsonist is often under a lot of tension and pressure at the time he sets a fire—or a series of fires. When this pressure is released, the arsonist will stop. "Simply being caught is often enough to stop their firesetting," Levin says.

However, the behavior pattern is established and, if an emotional upset recurs, the individual may return to arson, even after a break of 20 years or more.

Criminal Record

Also according to Levin's literature search, the arsonist is frequently a person in trouble with the law for other, unrelated crimes. One major study of over 1,300 arsonists found more half had been in trouble for a variety of misdeeds ranging from petty theft to manslaughter. There is even one type of arsonist who sets fires in order to cover up another criminal act. This was the case in a disasterous fire that gutted a Port Chester, N.Y., discotheque in 1974 and killed 24 persons. The fire was set by a man who was trying to disguise a robbery he committed in an adjoining building.

And then there is the arsonist who has a gasoline can and will travel. This is the person who will ignite an office or warehouse—if the price is right. Very little is known about the psychology of these individuals.

A typical arson-for-profit scenario might be the businessman who sets fire to his own business—or hires someone to do it—in order to collect the insurance. This is the most rapidly increasing form of arson.

Other scenarios might involve the housewife who sets a smokey fire to collect insurance money for redecorating or the welfare recipient who sets fire to his apartment to collect relocation expenses.

Prevention

Arson-for-profit is the easiest to prevent. Since it is a rational act, it can be thwarted by removing the incentive for the act. "The insurance companies might take a hard attitude and not pay off these fraudulent claims," Levin says. By adopting this attitude and publicizing it, he believes much of the profit motive will be eliminated.

What about the psychopath? How is he to be thwarted? Punishment and fear of punishment often don't work. But Levin maintains this should not discourage efforts to apprehend arsonists. While in custody the arsonist is removed from society and cannot set fires.

"In addition, some pyromaniacs stop their firesetting as soon as they are caught, whether or not they are jailed, punished, or treated; for them, firesetting is like an appeal for attention, with the arrest satisfying the need," Levin notes in his review.

The Bureau of Standards was given specific authority by Congress in the 1974 Fire Prevention and Control Act to establish an arson research program. Levin hopes to be able to continue his exploratory studies. Arson and the motivational characteristics of arsonists will be coming under closer scrutiny by NBS in the future. □

HIGHLIGHTS

Voluntary Product Standard

Printed copies of Voluntary Product Standard PS 65-75, "Paints and Inks for Art Education in Schools," are now available from the U.S. Government Printing Office.

The purpose of the standard is to establish nationally recognized quality requirements and package sizes for paints and inks used for art education in schools and to provide producers, distributors, and users with a basis for common understanding of the products' characteristics.

PS 65-75 is also designated as American National Standard Z 297.1-1975. Printed copies may be ordered prepaid for 35 cents by SD Catalog No. C13.20/2:65:75 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Magnetic Disk Calibration

The Institute for Computer Sciences and Technology has extended its unrecorded low and medium density magnetic disk calibration services to include high density (twelve-disk pack) data surfaces. Each high density data surface submitted will be calibrated with respect to the primary standard reference data surface established and maintained by NBS. Submissions will be calibrated at both 1.6 MHz and 3.2 MHz on tracks 000 and 410. The cost for this service is $312. Requests for additional information or submissions for calibration should be addressed to: Data Acquisition and Storage Section (Magnetic Disk), Computer Systems Engineering Division, B212 Technology Building, NBS, Washington, D.C. 20234. Phone: 301/921-3723.

Phase Diagrams Workshop

A 4-day workshop on applications of phase diagrams in metallurgy and ceramics will be held at the National Bureau of Standards in Gaithersburg, Md., on January 10-13, 1977. Workshop sessions are tentatively planned to include: present status of phase diagram compilation activity, user needs for phase diagrams, experimental and computational techniques to generate phase diagrams, presentation methods for and distribution of phase diagram data.

The workshop is sponsored by the NBS Institute for Materials Research and the Office of Standard Reference Data. Persons interested in contributing presentations at the workshop should contact Dr. Lawrence Bennett, B150 Materials Building, NBS, Washington, D.C. 20234. For additional information, write to Ronald B. Johnson, B348 Materials Building, NBS, Washington, D.C. 20234.

Computer Advice to Air Force

NBS has been asked by the Air Force to survey existing standards for computer-aided manufacturing (CAM) and to recommend areas for future standards development. This project is part of what is expected to become a more than $100 million effort by the Air Force to advance CAM state-of-the-art. Emphasis will be on the development of the general CAM technology directed toward demonstration of CAM techniques in sheet metal fabrication and assembly.

"Think Metric" Exhibit

Audience participation is the key to the National Bureau of Standards' "Think Metric" exhibit which is on loan to the Kennedy Space Center for its Bicentennial Exposition. Persons of all ages will find enjoyment as they play one of the metric games or take their height and weight measurements. The exhibit was designed to show that "going metric" can be fun—and that most persons will need to know only a few metric units for everyday living. Anyone interested in additional, detailed information on the metric system should contact the Metric Information Office, National Bureau of Standards, Washington, D.C. 20234.

MAP For Gage Blocks

A series of NBS publications is now available describing a measurement assurance program (MAP) for gage block calibration in the size range from 5 to 20 inches. These documents will be the principal means for making MAP available to metrology laboratories throughout the country. The key document in the series is NBS 149 "Measurement Assurance Program—A Case Study: Length Measurements. Part 1, Long Gage Blocks (5 in. to 20 in.)" It contains descriptions of the MAP philosophy, the development of a measurement process, and the analysis and interpretation of data from the process. The supporting documents give detailed information on the various aspects of the program.

All the information needed to establish a gage block measurement assurance program is contained in these publications. Additional publications that cover the size range below 5 inches are near completion. For ordering information, contact Paul E. Pontius, A123 Metrology Building, NBS, Washington, D.C. 20234. Phone: 301/921-2511. □

Promising MHD Electrode Materials Reported

A number of high temperature spinels appear to hold promise as building blocks of a key component in magnetohydrodynamic (MHD) electric generating systems, according to chemist Hans Frederikse of the National Bureau of Standards.

Speaking at the 15th MHD Symposium in Philadelphia, Pa., Dr. Frederikse said that experiments at NBS indicate that magnesium chromite and magnesium aluminate spinels with magnetite withstand the rigors of an MHD environment quite well and are promising candidate materials for MHD electrodes. The investigation was sponsored by the Energy Research and Development Administration (ERDA).

The development is of potential significance in current worldwide efforts to make MHD a practical means of generating electricity. MHD electric generating systems are thought to be more efficient and less polluting than conventional forms of electric power generation. However, one of the main obstacles in MHD systems is finding materials that can withstand extreme conditions of temperature, pressure, and corrosive chemicals.

Frederikse and his coworkers William R. Hosler, Alan J. Armstrong, and Dr. Taki Negas, measured the electrical conductivities of 10 samples of magnesium chromite and magnesium aluminate spinels with magnetite as a function of temperature and oxygen pressure. Six samples were obtained from commercial sources and four were prepared at the NBS laboratories in Gaithersburg, Md. Spinels are solids of cubic symmetry with 24 cation (positive ion) sites—8 tetrahedrally surrounded by oxygen ions and 16 octahedrally coordinated. The general chemical formula is $A_8B_{16}O_{32}$.

The NBS team found that the NBS-prepared magnesium chromite spinel showed excellent conductivity over the entire temperature range of the test, 800 to 1900 K. Another spinel developed at NBS, made of magnesium aluminate, also had electrical conductivities of acceptable magnitude in the lower temperature range.

In addition to the 10 magnesium chromite and aluminate spinels tested, the NBS scientists also studied the properties of an iron-cobalt spinel. This material melts above 1873 K and retains the spinel structure over a large temperature range. Its electrical conductivity is high down to 800 K. At this temperature, the materials could be brazed to a metal-alloy lead out (such as stainless steel) without much danger of corrosive decay through oxidation, Frederikse said. The material may thus be a prime "lead out" material (the point at which the electric current leaves the MHD channel).

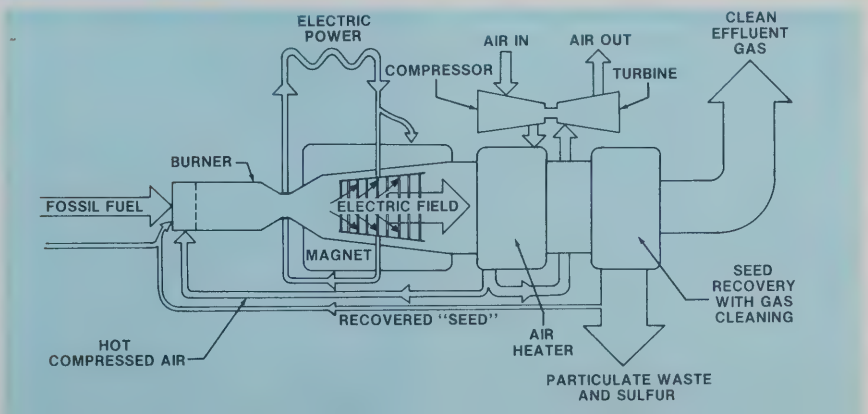
Studies on MHD sponsored by ERDA and carried out at NBS are aimed at providing endurance and property data on MHD materials, obtaining criteria for MHD system design, and assisting in developing specifications and test materials for containment materials.

The NBS-developed spinels are being investigated further, according to Frederikse, for possible testing in the joint U.S.-U.S.S.R. test this summer in the U-02 MHD generator in Moscow.

Last year, 20 zircoina-based electrodes were tested by the U.S.-U.S.S.R. team of scientists in the U-02 generator in Moscow. Another NBS scientist, Samuel J. Schneider, reported at the 15th MHD meeting that 14 of the 20 electrode pairs performed satisfactorily during the entire test. Five pairs failed early in the life test and the sixth pair failed in the last several hours. However, the failures were caused by "lead out" melting and not by electrode material degradation, Schneider said.

NBS had the prime responsibility for coordinating all materials characterization and evaluation activities of the first joint U.S.-U.S.S.R. test. □

Shown here is a schematic diagram of Avco-Everett MHD generator. In the most common form of MHD, a fossil fuel—such as natural gas, petroleum, or coal—is burned in a combustion chamber with preheated and/or oxygen enriched compressed air to produce temperature in the range of 2500 to 3000 K. The combustion products are seeded with an easily ionized element to increase electrical conductivity of the hot gases. The expanding gases propel themselves through a channel situated between poles of a magnet. By placing electrodes on the channel wall perpendicular to the fluid stream and magnetic field, direct electric current is obtained at relatively high voltages. An advantage to MHD is that high sulfur coal can be used.



Standard Issued on Bomb Disarmament X-Ray Systems

WELCOME technical support for the high-risk squads who deal with bombs planted in public places is now available in a new voluntary national standard on x-ray systems for bomb disarmament.

Bomb squads use x-ray devices to get an inside look into suspected objects that may or may not be bombs and that may or may not explode when handled "blind."

The standard establishes requirements and test methods for portable x-ray systems for use in bomb disarming operations. It was developed by the Law Enforcement Standards Laboratory (LESL) of the National Bureau of Standards, in collaboration with the NBS Applied Radiation Division. The Justice Department's Law Enforcement Assistance Administration (LEAA) has issued the standard through its National Institute of Law Enforcement and Criminal Justice (NILECJ).

Identified as NILECJ-STD-0603.00, the standard covers:

- Battery-Powered X-ray Systems.
- Alternating Current (AC)-Powered X-ray Systems.
- Optional Power X-ray Systems, in which the operator can select either battery-powered or AC-powered operation.

Requirements spelled out in the standard are applicable to questions of leakage radiation, image quality, ruggedness, temperature, power, set-up and operating time, portability, fire and shock, remote control and viewing, and other important considerations affecting performance and safety.

The standards' test methods include tests for leakage radiation, image quality-differential sensitivity, image quality-inherent sensitivity, a drop test, temperature tests, and power tests.

NILECJ has approved and issued the new voluntary product standard under priorities established in cooperation with hundreds of police departments throughout the United States.

Among those responding to a 1972 LEAA/NBS police equipment survey, officials in the nation's 50 largest cities ranked bomb disposal devices third in the Protective Equipment and Clothing category of items urgently in need of standards.

NILECJ-STD-0603.00 can be used by police purchasing agents to determine first-hand whether a particular equipment item meets requirements for high-quality performance, or they may have the tests conducted on their behalf by a qualified test-

Free Service for Explosive Vapor Detectors

LAW enforcement agencies using vapor detectors to "sniff" the presence of explosives can now take advantage of a free National Bureau of Standards service to check the sensitivity of their instruments.

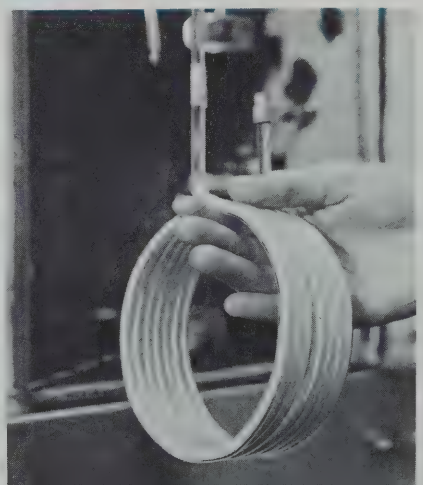
The checks are made with an NBS-developed trace vapor generator that produces known concentrations of several explosive vapors. Heretofore, accurate determinations of vapor detector sensitivities have been generally lacking.

NBS developed the vapor generator in work coordinated by its Law Enforcement Standards Laboratory (LESL) on behalf of the Justice Department's National Institute of Law Enforcement and Criminal Justice (NILECJ).

Costs of conducting the sensitivity tests and shipping the devices back to owners are being met with NILECJ funds. Owners pay only the cost of shipment to NBS.

For further information about the vapor generator service, contact Robert Mills, Program Manager for Investigate Aids, Law Enforcement Standards Laboratory, National Bureau of Standards, Washington, D.C. 20234. Telephone: 301/921-3161. □

This coil is part of an NBS trace vapor generator. When it is placed in a temperature bath and air is passed through one side of the coil, the result on the other side is an equilibrium vapor concentration of the explosive.



ing laboratory. The standard may also be referenced in police purchase documents detailing the requirements to be met by equipment suppliers.

As a technical resource of the LEAA program, LESL develops new and improved techniques, systems, and equipment to strengthen the law enforcement and criminal justice agencies in the selection and procurement of quality equipment.

Established by an interagency agreement between NBS and LEAA in 1971, LESL is supplying the law enforcement community with technical reports, state-of-the-art surveys, user guidelines, and national voluntary standards for equipment.

Current LESL contributions encompass communications equipment, security systems, investigative aids, protective equipment, police vehicles, court systems, and other aspects of law enforcement.

Order printed copies of NILECJ-STD-0603.00 PREPAID at 45 cents a copy and by GPO Stock No. 027-000-00343-5, from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Foreign remittances must be U.S. exchange and include an additional 25 percent of the publication price to cover mailing costs. □

Calibration Service Offered for Impulse Generators

THE National Bureau of Standards Electromagnetics Division, Boulder, Colo., is offering a new calibration service for impulse generators. The service features automated measurement of spectrum amplitude, a quantity which tells how energy in an electromagnetic impulse is distributed in frequency.

Most impulse generators are used for calibrating broadband receivers which measure the electromagnetic noise emitted by electrical and electronic systems. Thus the NBS service will interest people concerned with questions of electromagnetic interference (EMI) such as: How much EMI will a device create? How susceptible is a device to EMI?

EMI researchers calibrate their broadband receivers by means of calibrated sources of broadband electric energy. Impulse generators are these sources. When calibrated by NBS, the customer's impulse generator becomes a transfer standard with NBS-traceable accuracy.

The NBS calibration system comprises a sampling oscilloscope interfaced with a minicomputer. The oscilloscope samples the impulse time domain waveform at many points and sends the information to the computer. A large number of waveforms are measured, stored, and averaged to give a better signal-to-noise ratio. The computer then uses the fast Fourier transform to compute the spectrum amplitude from the impulse waveform.

Every impulse generator is also checked on a spectrum analyzer to be sure it does not have secondary impulses escaping the oscilloscope's time window. Instruments with such impulses are rejected for calibration.

Typically there are about 100 data points given in the calibration report though the number can depend upon the shape and duration of the impulse. The data, in units of decibels (dB) relative to one microvolt per megahertz (MHz), has uncertainties which increase from ±0.6dB to ±1.6dB across the range of frequencies covered in the calibration service (10 MHz to 6 gigahertz). Spacing between data points can be 10, 20, 50, or 100 MHz.

NBS charges about $475 to calibrate a mercury-switch generator with adjustable output amplitude. Additional charges are made for fixed-output generators exceeding 400 millivolts.

Computers, optical communications, radar, lasers, and other high technology fields have spawned the development of electrical and optical devices which operate in billionths of a second. The NBS Time Domain Metrology Program at Boulder was established to keep measurement methods and standards apace with the growth of this picosecond (10^{-12} second) pulse technology.

Further information is available through Dr. James R. Andrews, Electromagnetics Division, National Bureau of Standards, Boulder, Colo., 80302, 499-1000, Ext. 3259. □

Manual for New Optical Standards Available

AT a time when changes in the base units of international measurements in radiometry and photometry are being proposed, the National Bureau of Standards has published the first issue of a new series of Technical Notes (910) to spell out written methods that will make these new physical standards more useful.

The new series, entitled "Self-Study Manual on Optical Radiation Measurements," edited by Fred E. Nicodemus, has been described as a boon for those needing to make accurate optical radiation measurement. The first issue contains the first three chapters of "Part 1—Concepts." Interested specialists include workers in such diverse fields as astronomy, heat-transfer, illumination, photometry, meteorology, photobiology, photo-chemistry, optical pyrometry, remote sensing and infrared applications.

Measurements by different instruments or techniques commonly disagree by 10 to 50 percent. Reducing the uncertainty of these measurements to 1 or 2 percent is an NBS goal now within reach. Not only will such measurements be more useful but much time and money lost in resolving discrepancies can now be saved.

Pointing out that most engineers really don't know enough about their optical measurements to define their accuracy with any degree of confidence, Robert D. Compton, *Electro Optical Systems Design* editor, notes that training of individuals in the art of optical measurements is considered by many to be the industry's most serious problem. The manual could be a unifying factor to a field plagued with too many units, difficult measurement processes, inadequate standards and a wide diversity of thought and nomenclatures. It "has potential of being the most important document that has ever been written on optical radiometry," Editor Compton concludes.

In recent years, the economic and social impact of radiometric measurements has increased significantly in the manufacture of cameras, color TV sets, copying machines, and light bulbs. Regulatory agencies are becoming concerned with ultarviolet radiation used for processing industrial coatings such as paints. Phototherapy, used for treatment of jaundice in the newborn, and solar heating are two other examples of optical radiation use.

The Manual, conceived by Henry J. Kostkowski in 1973, incorporates comments and suggestions of more than 50 individuals, notably key members of the Council on Optical Radiation Measurements (CORM) and CORM's coordinators. Editorial aid was provided by Albert T. Hattenburg. Donald A. McSparron, Joseph C. Richmond, and John B. Shumaker of the NBS staff.

Designed as a definitive tutorial treatment, complete enough for self instruction, the manual is also a convenient and authoritative reference source. It is organized into three parts:

- Concepts—Useful quantities defined and discussed and their relevance to various applications in many different fields indicated.
- Instrumentation — Descriptions, properties, and other pertinent data concerning typical instruments, devices, and components involved in common measurement situations.
- Applications — Techniques for achieving a desired level of, or improving, the accuracy of a measurement. Examples drawn from the widest possible variety of areas of application in illumination engineering, radiative heat transfer, military infrared devices, remote sensing, meteorology, astronomy, photochemistry, and photo-biology.

Since basic quantitative relations for the propagation of energy by coherent radiation (e.g. laser beams) are not yet worked out, the manual deals only with the classical radiometry of incoherent radiation.

Additional chapters will be published as they are completed. Readers are invited to submit comments, criticisms, and suggestions. Particularly welcome are problems and examples from as widely differing areas of application as possible.

Copies of the first Technical Note in the Manual series are for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (Order by SD Catalog No. C13.46:910-1). Price $2.10 (Add 25 percent additional for other than U.S. mailing). □

these areas, most of the principal conclusions of the original ERDA Plan of June 1975 remain valid today.

Some shifting in emphasis is noted in the revised plan, notably the elevation of conservation technologies to the category having the highest priority for research, development, and demonstration (RD&D) support by ERDA. By conservation, we mean the more efficient use of energy as well as the reduction of needless waste.

National Technology Goals

To establish priorities in technology RD&D and to develop strategies of implementation in the commercial sector, the Plan sets forth eight national energy technology goals:

- Expand domestic supplies of economically recoverable, energy-producing raw materials, such as oil, gas, coal, and uranium.
- Over the longer term, increase the use of essentially inexhaustible domestic energy resources, for example, electrical conversion of solar energy, deuterium in the oceans using fusion power, and uranium 238 with breeder technology.
- Transform such abundant fuel resources as coal into more desirable end-use forms, that is, into clean-burning liquid and gas substitutes.
- Augment the efficiency and reliability of the processes used in energy conversion and delivery systems—improved converter-type nuclear power reactors, for example, and better electrical power transmission and distribution.
- Change consumption patterns to improve energy use, an example being the introduction of solar heating and cooling technology into the residential and commercial building markets.
- Increase the efficiency of end-users, such as improved automotive vehicles, appliances, and industrial equipment.
- Perform basic and supporting research and technical services directly and indirectly related to energy; typically, these include exploration and resource assessment, nuclear fuel cycle support, and fossil fuel transportation such as coal slurry lines.
- Protect and enhance the general health, safety, welfare, and environment during the course of energy development and systems implementation; the introduction of environmental control technologies and the establishment of standards of environmental performance of each technology concept are included in this area.

Strategic Approach to Energy RD&D

As the National Energy Plan evolved, various research, development, and demonstration programs were recommended to implement these priorities, all with the aim of facilitating the changeover from a diminishing base of oil and natural gas resources to a broad range of alternative—and much less limited—resources.

The exploitation of these resources will require the development of many new energy technologies. Since the private sector is the main producer

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The planned Clinch River Breeder Reactor, shown in this artist's rendering, will expand available uranium resources by transforming uranium-238, the non-fissionable part of natural uranium, into plutonium-239, which is fissionable and usable as a reactor fuel. The breeder creates more fuel than it uses as it operates.

photo courtesy ERDA

Table 1

Highest Priority Demand

Near-Term Efficiency (Conservation Technologies)	• Conservation in Buildings & Consumer Products • Industrial Energy Efficiency • Transportation Efficiency • Waste Materials to Energy

Highest Priority Supply

Major Near-Term Energy Systems	• Coal—Direct Utilization in Industry and Utilities • Nuclear-Converter Reactors • Oil and Gas—Enhanced Recovery
New Sources of Liquids and Gases for the Mid-Term	• Gaseous and Liquid Fuels from Coal • Oil Shale and Tar Sands
"Inexhaustible" Sources for the Long-Term	• Breeder Reactors • Solar Electric Systems • Fusion Systems

Important Technologies

Under-Used Mid-Term Technologies	• Geothermal • Solar Heating and Cooling • Waste Utilization
Technologies Supporting Intensive Electrification	• Electric Conversion Efficiency • Electric Power Transmission and Distribution • Electric Transport • Energy Storage
Supporting Technologies Being Explored for the Long Term	• Fuels from Biomass • Hydrogen in Energy Systems

Table 2

Facilities	*Potential Number Required*
Coal-Fired Power Plants (1000 MWe equivalent)	220
Lightwater Reactor Power Plants (1000 MWe equivalent)	370
Breeder Reactor Power Plants (1000 MWe equivalent)	80
Geothermal Power Plants (100 MWe equivalent)	400
Solar Electric Power Plants (100 MWe equivalent)	200-400
Coal Mines (millions of tons/year equivalent)	2,000
Oil From Shale Plants (50,000 b/d oil equivalent)	140
Coal Liquefaction or Gasification Plants (50,000 b/d oil equivalent)	80 140
Solar Heated and Cooled Buildings (millions)	10-15
Heat Pumps (millions)	26
Electric Automobiles (millions)	15

and consumer of energy, it is going to be up to it—and not the government—to assume the principal role of moving these technologies from early development through the demonstration phase and into the marketplace. The role of ERDA, and of other Federal agencies involved in energy, is and must remain supplementary.

Ultimately, the actions of private enterprise and of the market forces that shape them will change the energy mix of our nation. Whereas fossil fuels—coal, oil, and gas—now supply nearly 94 percent of the overall energy requirements of our country, by the year 2000 they may only provide between 65 and 70 percent. Nuclear's contribution is expected to rise from the current 2.3 percent to between 25 and 30 percent; hydropower and geothermal systems may account for approximately 4 percent. Solar heating and cooling should contribute an additional few percent.

RD&D Priorities

To accomplish near-, mid-, and long-term energy goals, national RD&D priorities have been tentatively established. Only by setting such priorities can resources be allocated effectively to the RD&D process with the reasonable expectation that a given energy technology will be ready when it is needed.

Priorities, like all else in the National Energy Plan, are—and of necessity must be—flexible. For example, the development of electrification and hydrogen fuel technologies has been given a relatively low priority today. Their positions, however, are apt to rise as confidence in breeder, solar electric, and/or fusion power systems increases in a decade or so.

Table 1 ranks the many RD&D technologies in which ERDA is involved. Regardless of the level now assigned the various energy technologies, all to a greater or lesser extent must be—and indeed are being—pursued. There are a number of compelling reasons for this.

The research, development, and demonstration of one or more technologies may fail or become seriously delayed, making it prudent that backup options be available at all times. Then, too, the long-term approaches have not yet been proven to be technologically, much less commercially feasible and will require an extended period of development.

Furthermore, in order to make the importing of significant quantities of foreign energy a matter of choice rather than of necessity, a broad range of new technologies must be introduced at the earliest possible time. Still another reason for avoiding new technology start-up delays is the possibility that some seemingly attractive energy systems may not be fully—or even partially—exercised because of environmental, economic, social, or other essentially non-technological restraints.

New Facilities and Equipment

As the United States begins to adapt these technologies on a widening scale, enormous investments in facilities, equipment, and trained manpower are going to be needed in the years ahead. Table 2 gives the

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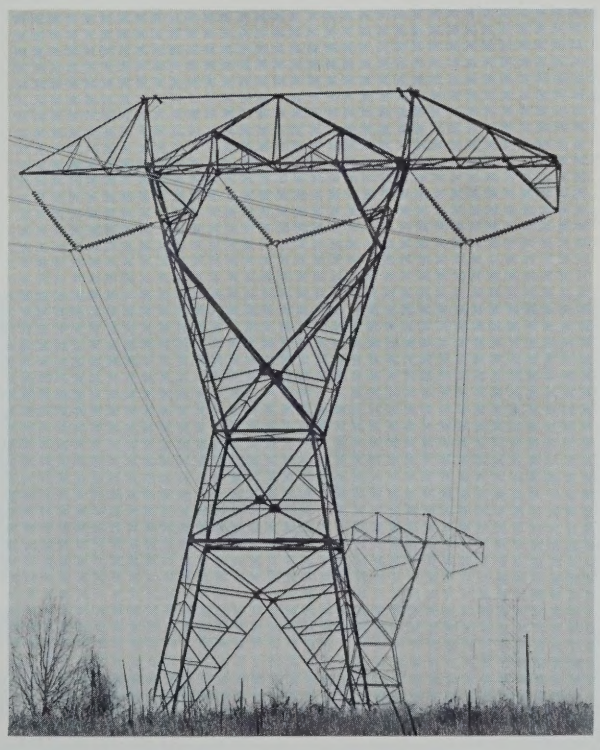

NBS is evaluating instruments and methods to measure electric fields near high-voltage transmission lines.

number of major facilities that, according to one of our scenarios, may be required by the year 2000.

Because the development of new energy technologies and the facilities to exploit them requires long lead-times with attendant economic and other uncertainties, potential customers may be reluctant to provide investment capital when it is most needed. Close Federal cooperation with the private utility and production sectors, therefore, has been and is being encouraged.

Such cooperation can include risk-sharing during the critical phases of research and technology development, price supports coupled with non-recourse guaranteed loans, accelerated depreciation, investment tax credits, and the enactment of favorable regulatory policies. Government help is also crucial in reconciling the operational characteristics of new energy systems with environmental, health, safety, and other requirements.

Also, on their own, Federal centers and laboratories conduct RD&D that can substantially contribute to the overall energy picture.

ERDA-NBS Programs

Many Federal centers and laboratories are involved, not only those attached to ERDA. Of the agencies active in the energy field, the National Bureau of Standards is conspicuous for the breadth of its contributions. In fiscal year 1976 alone, ERDA transferred to the NBS $5.8 million in spending authority which has been added to a $3 million carry-over. With this funding, a total of 44 separate projects grouped in five major program areas are now being supported.

Approximately $1.3 million has been allocated to evaluating energy-related inventions submitted by individual inventors and small businesses. After working their way through an intensive screening process, attractive candidates may be given ERDA development support. Of the 3,000 inquiries received up to mid-February 1976, 1,200 have passed the screening review established by the Office of Energy-Related Inventions. Of these, 400 were selected for first-stage evaluation, 200 already have been evaluated, and 24 succeeded in reaching second-stage evaluation. Thirteen of this group subsequently entered the process and five by mid-February worked their way through, yielding two inventions that have been recommended to ERDA for support.

In another program area, some $2.4 million has been budgeted for such fossil energy projects as materials research related to magnetohydrodynamics on the electrical conductivity, viscosity, and chemistry of coal slags, the development of test methods to determine erosion and stress corrosion of metals in coal gasification plants, and the study of the damage of catalysts used for fuel cells.

Within the conservation area, supported by $1.8 million, the NBS is evaluating the performance of a test facility heated by solar collectors and at the same time is studying the energy performance of buildings to determine how much insulation and other energy-related modifications they may require for maximum fuel economy. For industrial use, data are generated and improved methods are developed to measure flow rate, temperature, and chemical composition of hot gases and flames in efforts to yield more efficient combustion. Tests of the substitution of waste products have also been carried out in paper and cement production.

Another area of great importance to ERDA is energy distribution and transmission. This involves about $1.2 million dispersed among such NBS projects as the evaluation of instruments and methods to measure electric fields near high-voltage transmission lines and the investigation of insulating materials that may be used for superconducting underground electric transmission. Another $2 million is represented by NBS' nuclear activities including the calibration of new types of neutron exposure dosimeters used by reactor personnel and the gathering of atomic and molecular data related to magnetic confinement and laser-induced fusion.

These are but examples of the important work the National Bureau of Standards is undertaking—work that contributes significantly to America's energy programs while strengthening the scientific and technological prestige of the United States.

Contrary to the idle dreams of a few, our nation and all other nations are going to demand vast quantities of energy for as far into the future as one is able to predict. What we are setting out to do today will make that future secure, for without energy, society as we conceive it would crumble. President Ford said recently, "I fully recognize that this country's future— and that of all civilization as well—depends on nuturing and drawing on the creativity of men and women in our scientific and engineering community." The truth of this is compelling. There can be no turning back to the simpler non-scientific, non-technological ways of the past—if, indeed, they were simpler. □

PUBLICATIONS

of the National Bureau of Standards

Building Technology

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